

WHAT IS CLAIMED IS:

- 1                   1.     An expandable seal capable of sealing a gap, the seal  
2     comprising:  
3                   a polymeric material including a foaming agent that has the  
4     characteristic of undergoing an increase in volume when subjected to an activating  
5     influence;  
6                   a heating agent for providing heat to at least partially melt the  
7     polymeric material and to at least partially activate the foaming agent, thereby  
8     facilitating expansion of the polymeric material to effect a seal; and  
9                   a heat conductive barrier surrounding at least a portion of the heating  
10    agent, thereby inhibiting mixing of the polymeric material and the heating agent, and  
11    inhibiting seal degradation,  
12                  wherein at least some of the polymeric material is in contact with an  
13    external surface of the barrier, thereby facilitating heat transfer from the heating  
14    agent to the polymeric material so that interstices and cavities extending from the  
15    gap are at least partially filled to promote sealing by a fluid composition formed as  
16    a result of thermal and chemical activity.
- 1                   2.     The seal of claim 1, wherein the polymeric material has a  
2     melting point at a first temperature, and the foaming agent is activated at a second  
3     temperature that is higher than the first temperature.
- 1                   3.     The seal of claim 1, wherein the barrier comprises a sheet of  
2     material surrounding a portion of the heating agent, such that the heating agent has  
3     at least one open end.
- 1                   4.     The seal of claim 1, wherein the barrier is selected from a  
2     group consisting of aluminum, brass, copper, nickel, iron, steel, and mixtures  
3     thereof.
- 1                   5.     The seal of claim 1, wherein the barrier has an average  
2     thickness from 0.0005 inches to 0.050 inches.

1                   6.     The seal of claim 1, wherein the polymeric material is selected  
2     from a group consisting of at least one of acrylic, acrylonitrile butadiene styrene,  
3     ethylvinylacetate, polyethylene, polyurethane-thermoplastic, polypropylene,  
4     thermoplastic vulcanizate, thermoplastic elastomer, polyvinylchloride, silicone,  
5     styrene, and mixtures thereof.

1                   7.     The seal of claim 1, wherein the foaming agent comprises  
2     azodicarbonamide.

1                   8.     The seal of claim 1, wherein the heating agent includes a fuel  
2     and an oxidizer.

1                   9.     The seal of claim 1, wherein the barrier is configured to at  
2     least partially direct the expansion of the polymeric material when the foaming agent  
3     is activated.

1                   10.    The seal of claim 9, wherein the barrier is generally  
2     cylindrical, thereby facilitating radial expansion of the polymeric material.

1                   11.    The seal of claim 9, wherein a cross section of the barrier  
2     forms three sides of a quadrilateral, and the polymeric material is disposed within  
3     the quadrilateral, thereby facilitating a generally linear expansion of the polymeric  
4     material through an open side of the quadrilateral.

1                   12.    An expandable seal configured for attachment to a flange and  
2     capable of sealing a gap associated with the flange, the seal comprising:  
3                    an elongate member having a cross section that includes a generally  
4     U-shaped portion that is configured to be disposed over at least a portion of a flange  
5     such that the gap exists between the elongate member and the flange;  
6                    a polymeric material including a foaming agent that has the  
7     characteristic of undergoing an increase in volume when subjected to an activating

8 influence, the polymeric material being disposed on at least a portion of an inside  
9 surface of the elongate member;  
10 a heating agent for providing heat to at least partially melt the  
11 polymeric material and to at least partially activate the foaming agent, thereby  
12 facilitating expansion of the polymeric material to fill at least a portion of the gap;  
13 and  
14 a heat conductive barrier surrounding at least a portion of the heating  
15 agent, thereby inhibiting mixing of the polymeric material and the heating agent, and  
16 inhibiting seal degradation,  
17 wherein, at least some of the polymeric material is in contact with an  
18 external surface of the barrier, thereby facilitating heat transfer from the heating  
19 agent to the polymeric material.

1 13. The seal of claim 12, wherein the polymeric material is  
2 configured to adhere to the flange when it expands, thereby eliminating the need for  
3 a carrier within the elongate member.

1 14. The seal of claim 12, wherein the polymeric material has a  
2 melting point at a first temperature, and the foaming agent is activated at a second  
3 temperature that is higher than the first temperature.

1 15. The seal of claim 12, wherein the barrier comprises a copper  
2 material having a thickness of approximately 0.002 inches.

1 16. The seal of claim 12, wherein the barrier is configured to at  
2 least partially direct the expansion of the polymeric material when the foaming agent  
3 is activated.

1 17. The seal of claim 16, wherein the barrier is generally  
2 cylindrical, thereby facilitating radial expansion of the polymeric material such that  
3 the polymeric material at least partially fills first and second gaps on opposing sides  
4 of the flange.

1                    18.    A method for producing an expandable seal having an integral  
2    heating agent, the method comprising:  
3                    disposing a heat conductive barrier around at least a portion of the  
4    heating agent;  
5                    disposing a polymeric material on an external surface of the barrier,  
6    thereby facilitating heat transfer from the heating agent to the polymeric material,  
7    the polymeric material including a heat-activated foaming agent for facilitating  
8    expansion of the polymeric material to effect a seal.

1                    19.    The method of claim 18, further comprising disposing the  
2    polymeric material within an elongate member configured for attachment to a  
3    flange, the polymeric material being positioned to at least partially fill first and  
4    second gaps on opposing sides of the flange.

1                    20.    The method of claim 18, wherein the heating agent includes  
2    a fuel and an oxidizer.